

Conflict Diagrams for Cross-examination Dialogues

Douglas Walton *Argumentation & Advocacy* (to appear, 2018)

Abstract: This paper builds a practical method of analyzing cross-examination dialogues by using tools adapted from formal dialectic and artificial intelligence to show how an argumentation model can shed new light on our understanding of actual cases of cross-examination in the common law courts. This is done by illustrating how the model brings out certain precise formal features of argumentative cross-examinations, which would otherwise be hidden from view. Cross-examination dialogue is further discussed in relation to ancient and contemporary approaches to formal dialectics.

Key Words: argumentation, formal dialogue models, examination, legal argumentation, questioning

1. Introduction

The aim of this paper is to build a practical method of analyzing cross-examination dialogues that enables the underlying argumentation structure of any particular example of this type of dialogue to be revealed. The dialogue is first represented as a table showing the sequence of speech acts representing the moves of the two principal participants. This dialogue is then mapped onto an argument diagram, a visual method of representing the central argumentation features embedded in the sequence of moves in the table. I call such an argument diagram a conflict diagram because it is meant to visually represent a conflict between a pair of propositions that an answerer has gone on record as accepting. As well as using argument diagramming techniques, argumentation schemes and recent artificial intelligence tools, the method is based on prior models of examination dialogue (Dunne et al, 2005; Walton, 2006) and a formal dialectical model built by Krabbe (2013) that represents a stylized form of debate known to the ancient Greek philosophers and identified with Aristotelian dialectic.

Throughout the *Topics* and *On Sophistical Refutations*, Aristotle outlined a dialectical game in which there are two participants called the Questioner and the Answerer¹ where the Questioner tries to trap the Answerer into a contradiction by putting a series of yes-no questions to him that he must answer, one way or the other. The purpose of this game is not entirely clear, but Aristotle tells us (*Topics*, 101a26-30) that it can be helpful for training in disputation. The contention of this paper is that Krabbe's formal model of the central core of it, along with some other tools from informal logic and artificial intelligence, enables the building of a practical method for analyzing the argumentation in some illustrative examples of cross-examination.

As the reader will know, cross-examination is a technique of trial advocacy (Levy, 2011). When an attorney examines his own witness it is called direct examination. When an attorney examines the witness of the opposing side, it is called cross-examination. One can easily find many examples of cross-examination in law (Lubet, 2000), and they have many interesting qualities as species of argumentation (Drew, 1992). This paper, however, does not claim to provide a full formal model of legal cross-examination or to cover many examples. It is meant to show that this formalization provides the basis of a simple practical method for analyzing argumentation in cross-examinations. By analyzing two relatively simple but common types of

¹ Some convention is needed to enable the reader to distinguish between the moves of the one party from those of the other in complex examples. The convention is herewith adopted of consistently designating the Questioner (the more powerful party) as *she* (*her*) and the Answerer as *he* (*him*).

examples, it offers some evidence to support the hypothesis this method might even be able to aid in the empirical task of better understanding - who knows, maybe even designing - actual contexts of argumentative discourse, such as legal cross-examination.

2. A Formal Model of Aristotelian Dialectic

Formal dialogue models representing normative rules for argumentation of various kinds have been found widely useful in argumentation studies (Walton and Krabbe, 1995). Just as each type of dialogue has its goal (Walton, 2013), the structural elements of an activity type are rationally and functionally adapted to its goal (Levinson, 1979, 369). For example, a court case can be divided into different phases or parts, including an initial statement of the case, putting forward of pro-con arguments by both sides, cross-examinations, a closing stage where a decision is made, and a stage where sentence may be passed (Levinson, 1979, 369).

Representing rational argumentation dialogue as a framework in which two participants question each other and advance arguments directed to the other, is a part of logic that goes back to Plato and Aristotle, and before them to the Sophists. In the 20th century it has come back into vogue following the logical work of the Erlangen School (Lorenzen and Lorenz, 1978) and Charles Hamblin. Hamblin (1970, 1971) constructed mathematical models of dialogue to model interesting features of rational argumentation. In this framework there are two participants (parties), often called White and Black, where each takes turns making a move composed of a so-called locution, such as making an assertion or asking a question. A *formal dialogue*, as defined in this paper, is defined as a triple, $\{m, n, p, \}$ where m is a move, n is a number representing the length of the dialogue (the number of moves so far), and $p (\geq 2)$ is a participant. Common types of moves are the putting forward of an argument and the asking of a question.

Hamblin's dialogue models of argumentation have been influential in the recent development of formal dialogue systems for argumentation recently developed in artificial intelligence (Reed, 2006). In this approach the rules, or so-called protocols that govern the dialogue, are defined by pre-conditions that determine when a given type of move can be put forward as a move, and post-conditions that determine the allowable responses by the other party. But one can also look in the other direction by observing that Hamblin's work was clearly inspired by ancient Greek dialogue systems, especially the ones in Aristotle's *Topics* (1939) and *On Sophistical Refutations* (1928). One of these systems will be the chief subject of this paper.

In outline the system is very simple, with only two participants called the Questioner and Answerer, and can best be introduced by seeing its outline as having three stages: an opening stage, an argumentation stage and a closing stage. Slomkowski (1997, 15) showed that the formulation of the problem, the so-called *problema*, comes at the beginning of the discussion. In the opening stage, the Questioner poses a problem (*problema*) in the form of a pair of propositions $(T, \sim T)$, where \sim represents negation. The Answerer must select one of the pair, which then becomes the proposition he must defend during the argumentation stage. This proposition is generally called the Answerer's thesis by Aristotle (Slomkowski, 1997, 16). The argumentation stage takes the form of an argumentation sequence in which the Questioner tries to entrap the Answerer into committing himself to inconsistency, by asking him a series of yes-no questions. A *yes-no question* is composed of a pair of propositions (P_i, P_j) where the Answerer has to select the one or the other at his next move. Whenever the Answerer selects such a proposition it is put into his store of commitments along with his thesis. The goal of the Questioner is to get the Answerer to become committed to a proposition that is the negation of a

proposition that is already in his commitment store. The closing stage is reached either when this happens or when the Questioner runs out of some pre-determined number of moves. In the former event the Questioner wins. In the latter event the Answerer wins.

This formal dialectical structure appears to represent a stylized form of debate, and there is a question whether such a debate is based on some real or realistic kind of debate format known to the Greeks. In the *Topics* (101a26-30), Aristotle tells us that the techniques used in his book are applicable to training in disputation, casual conversations and philosophical sciences. The training in disputation refers to meetings for discussion where the disputants argue for the sake of examination and inquiry (Slomkowski, 1997, 12). Aristotle makes it clear in book 8 of the *Topics* that he is not the inventor of the dialectical debates used in such discussions when he writes that there are no definite guidelines laid down for those who engage in such dialectical discussions (8, 159a25). This kind of textual evidence found in book 8 of the *Topics* suggests that Aristotle's formal system of dialectical argumentation was based on kinds of discussions or debates that were familiar in ancient Greek culture. One might also mention here the use of the style of examination familiarly used by Socrates in the early Platonic dialogues called the *elenchus*, which appears to have some features of resemblance to Aristotle's dialectical system.

The central core of this Aristotelian system of dialectical argumentation has been modeled by Krabbe (2013) as a formal dialectical system called ACADEMIC₁ using Hamblin-style rules (Hamblin, 1970, 1971) of the kind later used in (Walton and Krabbe, 1995). In this style of formulation, there are *locution rules*, defining the moves that can be used at each step, *structural rules* that define the order of turn taking and what moves are acceptable as responses, *commitment rules* that define which propositions go into each arguer's commitment set at each move made, and *rules for winning and losing*, defining what sequences of moves by each party count as winning or losing. In this paper a different style of formalization will be used where the structure of the system follows more recent conventions and terminology for formal dialogue systems in argumentation studies. However the rules follow those of Krabbe precisely and the resulting system has the same formal properties as that of Krabbe.

In the model of Krabbe (2013), the Questioner can put forward an argument *as a move* in the format $P_1, \dots, P_n/C$ provided that the argument is deductively valid and the Answerer is committed to all the premises. The Questioner has the additional option of arguing by *reductio ad absurdum*, which we will here equivalently call *reductio*, a form of argument that is supposed to be deductively valid. According to this rule (Krabbe, 2013, 75), the Questioner may use P_1, \dots, P_n along with a hypothesis H to build a *reductio* argument of the form $P_1, \dots, P_n, H/C$ to force the Answerer to concede $\sim H$ if C is inconsistent. This move is included in the list of moves in Table 1. $\sim H$ could be the negation of the Answerer's thesis or it could be any other proposition, including the negation of some other proposition the Answerer is committed to.

In the style of protocol represented in table 1, six moves that are allowed are displayed in the left column, and the precondition for each move is shown in the right column. The Questioner is represented as Q and the Answerer as A .

Move	For	Precondition
<i>Problem</i> $T/\sim T$ (<i>Posing a Problem</i>)	Q	Must be the first move at the opening stage.
<i>Thesis</i> T (<i>Choosing One's Thesis</i>)	A	Must be preceded by a problem posed by Q.
<i>Question</i> $P/\sim P$ (<i>Asking a Yes-No Question</i>)	Q	Can be asked anywhere at Q's turn during the argumentation stage.

<i>Argument $P_1, \dots, P_n/C$ (Making an Argument)</i>	Q	$P_1, \dots, P_n/C$ must be valid, and A must be committed to P_1, \dots, P_n .
<i>Reductio $P_1, \dots, P_n, H/C$ (Reductio Ad Absurdum)</i>	Q	$P_1, \dots, P_n/C$ must be valid, A must be committed to P_1, \dots, P_n , and C must be inconsistent.
<i>Concession P (Making a Commitment)</i>	A	Must be a response to the asking of a yes-no question by Q.

Table 1: Preconditions for Each Move

Now that the preconditions of the protocol have been defined, the post-conditions can be defined in a comparable dialogue table shown in this table 2.

Move	For	Required Response	Commitment Effect
<i>Problem $T/\sim T$ (Posing the Problem)</i>	Q	Must immediately be followed by A's selecting T or $\sim T$.	A is committed to T or to $\sim T$.
<i>Question $P/\sim P$ (Asking a Yes-No Question)</i>	Q	Must immediately be followed by A's selecting P or $\sim P$.	A is committed to P or to $\sim P$.
<i>Argument $P_1, \dots, P_n/C$ (Making an Argument)</i>	Q	Assuming that $P_1, \dots, P_n/C$ is valid and A is committed to P_1, \dots, P_n , A must concede C.	A is committed to C.
<i>Reductio $P_1, \dots, P_n, H/C$ (Reductio Ad Absurdum)</i>	Q	Assuming that $P_1, \dots, P_n/C$ is valid, A is committed to P_1, \dots, P_n , and C is inconsistent, A must concede $\sim H$.	A is committed to $\sim H$.
<i>Thesis T (Choosing One's Thesis)</i>	A	None required.	A is committed to T .
<i>Concession P (Making a Commitment)</i>	A	None required.	A is committed to P .

Table 2: Post-Conditions for Each Move

Along with pre-and post-conditions specified in tables 1 and 2, several other rules and features need to be added to build a formal system equivalent to that of (Krabbe, 2013). First, the system must have a feature called a commitment store by Hamblin, a set of propositions that can be varied at each move of the dialogue, as indicated in table 2, such that propositions can be added to this set or deleted from it as moves are made in the dialogue by the one participant or the other. Also, it is a general procedural rule that the two speakers take turns making their remarks, and it is assumed that each speaker can only make one move at a given turn. There are two other structural rules called S7 and S9 (Krabbe, 2013, 76) that also need to be added.

(S7) Argument $P_1, \dots, P_n/C$ must be followed by 'Concession C'.

(S9) Reductio $P_1, \dots, P_n, H/C$ must be followed by 'Concession $\sim H$ '.

It should also be added that in this system all that is important in calculating the outcome are the commitments of A. Hence there is no need to have a commitment store for Q. Also there is no move to allow A to retract a commitment. The commitment set is cumulative in the sense that once a proposition is contained in the store, it always remains there.

3. Mapping a Dialogue Table onto a Conflict Diagram

In this section a different (but equivalent) way of framing the rules of ACADEMIC_1 is formulated which is more in line with the current conventions used in artificial intelligence so that the system can be used as part of a framework for research on providing a method for evaluating argumentation used in cross-examination dialogue. The method will begin by displaying the sequence of dialogue in a natural way as a table with a left column displaying the moves of the Questioner and the right column displaying the moves of the Answerer. Each pair of moves is called a round of play with each round numbered.

A short example illustrating how a sequence of examination dialogue can be represented is shown in table 3. In this example proposition P_5 is in the IP (impossible proposition), the Questioner puts forward a *reductio ad absurdum* argument the set of sentences that express impossible propositions. Each pair of question and reply moves is numbered in the R (round of play) column on the left. To begin play, at the first round, the Questioner offers the Answerer a choice of which thesis he accepts, T or $\sim T$. The Answerer chooses T . At the next three rounds, the Questioner asks the Answerer whether he accepts each of three propositions, and the Answerer accepts all of them. At the fifth round, the Questioner puts forward a valid argument with three propositions as premises that the Answerer has previously accepted. At the sixth round, she puts forward a *reductio ad absurdum* argument in which the first four premises are propositions already accepted by the Answerer and the fifth proposition is a hypothesis. The conclusion is the impossible proposition P_5 . According to the ninth structural rule of ACADEMIC_1 , this type of move must be followed by the reply ‘Concession $\sim H$ ’. At the seventh round, the Questioner puts forward an argument in which both premises were previously accepted by the Answerer, which is a valid argument, and which has the conclusion P_3 . But since the Answerer was already committed to $\sim P_3$ at round four, is now committed to the inconsistency $P_3 \& \sim P_3$, as shown in round eight. Hence he loses.

R	Questioner (Q)	Answerer (A)
1	$T/\sim T$	T
2	Question P_1	Concession P_1
3	Question P_2	Concession P_2
4	Question $\sim P_3$	Concession $\sim P_3$
5	Argument $P_1, P_2, \sim P_3/P_4$	Concession P_4
6	Reductio $P_1, P_2, \sim P_3, P_4, H/P_5$	Concession $\sim H$
7	Argument $P_4, \sim H/P_3$	Concession P_3
8	Inconsistency ($P_3, \sim P_3$)	A loses

Table 3: An Example of a Dialogue Sequence in ACADEMIC_1

Strictly speaking, the pair R8 is not a pair of moves, because there are no moves corresponding to ‘inconsistency’ or ‘A loses’. These moves could be added if we want to represent the closing stage as well as the opening and argumentation stages.

Once an examination dialogue of this type is set up using a stencil of the kind provided by the example shown in table 3, another device called a conflict diagram can be introduced. A *conflict diagram* is a graphical representation of the sequence of argumentation implicit in any given example of a real examination dialogue once it is put into the dialogue format shown in

table 3.² A graph is defined as a set of vertices (points, nodes), and a set of edges (lines, arcs, arrows) joining the nodes. Mathematically a *graph* G is defined as an ordered pair (N, A) , where the set A is comprised of the two-element subsets of N (Harary, 1972, 9). A *path* from node s to node g is a sequence of nodes $\{n_0, n_1, \dots, n_k\}$ such that $s = n_0$, $g = n_k$, and $\{n_{i-1}, n_i\} \in A$ (Poole and Macworth, 2011, 75). In other words, there must be an arc from n_{i-1} to n_i for each i . The graph shown in figure Y has three different kinds of nodes. The round nodes stand for arguments that can be pro (+) or con (-). The rectangular nodes stand for propositions that are premises or conclusions of arguments. The octagonal node stands for a conflict, representing a pair of propositions that are logically inconsistent. Argument a1 that has three premises, P_1 , P_2 and $\sim P_3$ (where \sim represents negation) supporting conclusion P_4 . A2 is a *reductio ad absurdum* argument that has two premises in addition to premise P_4 , H , a hypothesis and P_5 , an impossible proposition. The argument +a2 supports $\sim H$, which in turn supports the conclusion P_3 . The argument +a3 supports $\sim H$, which in turn supports the conclusion P_3 .

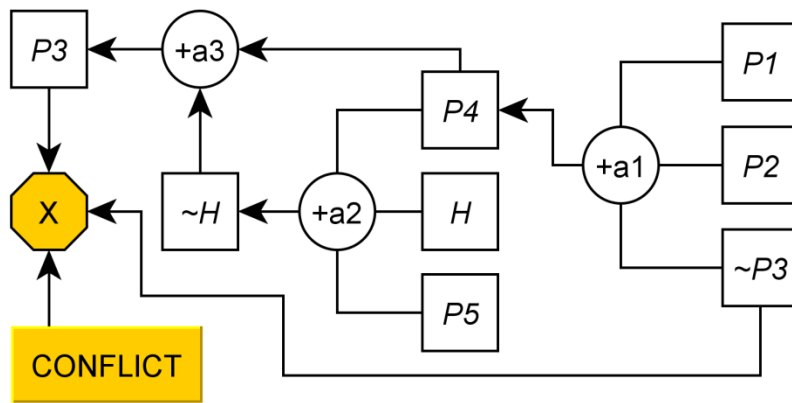


Figure 1: Conflict Diagram of the Argumentation in the Example Dialogue Sequence

Figure 1 shows that the Answerer, who was committed to $\sim P_3$ at the outset of the sequence, has now become committed to P_3 at the end of the sequence of questioning. Hence the Questioner wins. The value of a conflict diagram is that it shows how the propositions accepted as commitments by the Answerer can be used as premises in arguments put forward as moves by the Questioner and how the arguments can be chained together forming two paths so that the paths lead to a conflict. Such a diagram can help the Questioner to build a strategy for a successful cross-examination in a given case, and it could also be used to help the Answerer avoid the conflict if the line of argument leading to the conflict can be anticipated.

In Hamblin's system (Hamblin, 1970), the commitment store (CS) is a set of propositions that is unique to each participant but are in a database that can be accessed by all the parties to the dialogue. In ACADEMIC₁ the Questioner can search in the Answerer's CS to find premises that she can use to construct arguments in her quest to prove the negation of his thesis. For this purpose the Questioner can use only deductively valid arguments, so there will have to be some list of valid arguments on view to both parties that the Questioner can use. Finally there will have to be some source of information to determine when the procedure is closed for lack of further time available. The obvious way to do this is to put a numerical limit on the number of moves

² The reader needs to be warned that the term 'conflict map' from dispute resolution (Wehr, 1979) refers to something different from a conflict diagram in the sense of the term defined in this paper.

available to the Questioner. Whatever device is used, the calculation can be made by using the information in the Time Expires rectangle.

So now we have a general overview of how the sequence of argumentation in an Aristotelian dialectical game works, as modeled by ACADEMIC_1 . An overview of the argumentation procedure of ACADEMIC_1 is shown in Figure 2.

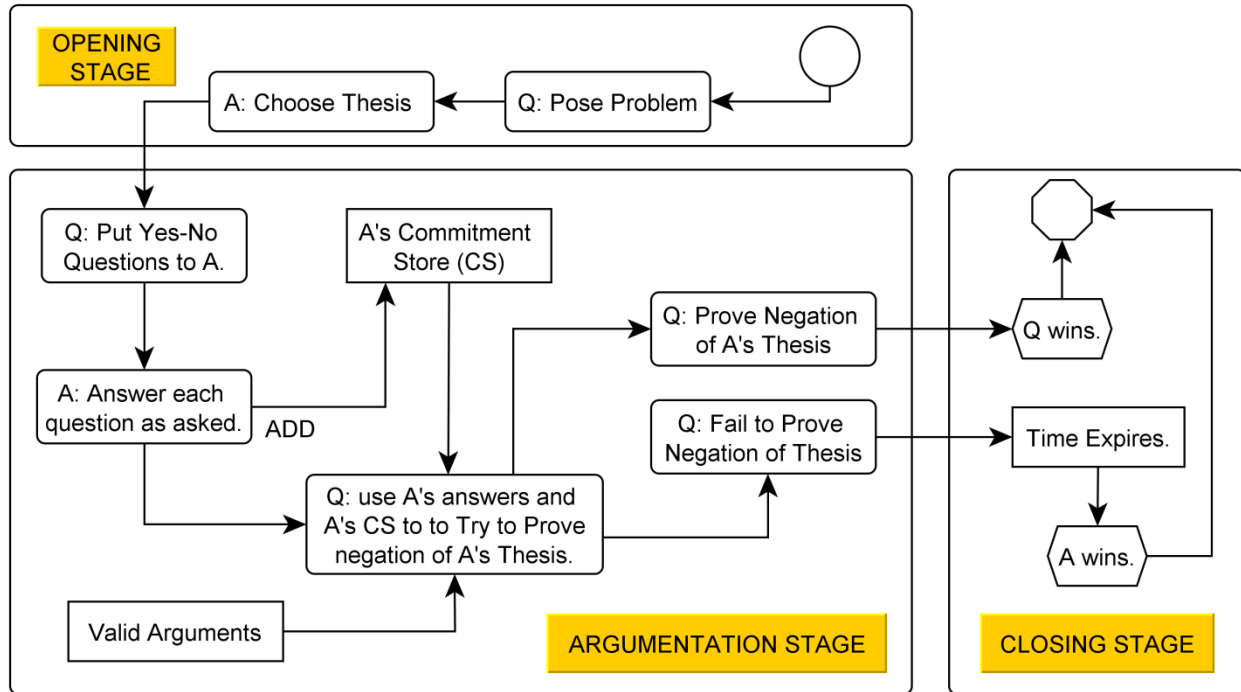


Figure 2: Overview of the ACADEMIC_1 Procedure

The procedure moves from the start point (the circular node at the top) to the end point (the hexagonal node at the top right). The sentences contained in the rounded rectangle nodes represent actions that the Questioner or the Answerer can or must carry out. The two rectangles with squared corners represent sources of information that are available to both parties.

4. Characteristics of Examination Dialogue

There are differences of opinions on how examination dialogue should be modeled and how the various subtypes of examination dialogue, such as cross examination, interrogation and so forth should be classified in argumentation theory. Dunne et al. (2005) offer arguments to support the approach that examination dialogue should count as a main type of dialogue in its own right, on a par with information-seeking and persuasion. Van Laar and Krabbe (2010) carefully analyze examination as a mixture of persuasion dialogue and inquiry (another main type). Here we adopt the approach of (Walton, 2008) because it is more straightforwardly applicable to the kinds of cross-examination dialogues treated in this paper.

Testing takes place by the use of critical argumentation to try to determine if the information that has been elicited in the dialogue exchange is true. A response is tested against the respondent's other statements or commitments, or other facts in the case. The formal analysis of

examination dialogue by Dunne et al. (2005) captures the central adversarial core of this testing function of examination dialogue. The proponent wins if he pins down an inconsistency in the commitments of the respondent. But there is more to it than that. In a trial, an examination dialogue is embedded in a wider persuasion dialogue which is adversarial in nature. The adversarial nature of examination and how it arises within the persuasion dialogue in legal trials are very well illustrated by the meticulous linguistic analysis of many real examples studied by Drew (1992), Lubet (2000) and Levy (2011).

Examination is an inherently asymmetrical type of dialogue. The two participants, whom Aristotle calls the Questioner and the Answerer, have different kinds of roles, as can be seen by the different kinds of moves they put forward as they take turns engaging in a dialogue. The role of the Questioner is to ask a series of questions, and the goal of the Questioner is to obtain information from the Answerer. The role of the Answerer is to answer the questions put to him by the Questioner. The collective goal of an examination dialogue as a distinctive type of multi-agent communication is to obtain reliable information from a source. But this goal has two subgoals. One is to obtain information and the other is to test the reliability of the information. In some cases, the one goal is more dominant while in other cases (and especially in cross-examination) the other goal is more dominant (Walton, 2006, 2008).

The two participants also have their own individual goals. The goal of the Questioner in an examination dialogue is basically to find information by putting a series of questions. The goal of the Answerer is to provide the kind of information sought for when a question is asked. However, the respondent may have something to conceal, and in order to conceal this information, he may lie, or give an answer that is misleading. Or on the other hand, because of the well-known fallibility of human memory, the Answerer may give a reply that is inaccurate, or even completely wrong, even though he thinks the information he gave is correct. Partly for these reasons, the Questioner often has a secondary goal, which is to test an answer for truth or accuracy. This testing function is a very important characteristic of examination dialogue in general. It is achieved by using critical argumentation used to judge whether the information presented is reliable, or even by trying to show that it is unreliable. To achieve this goal, the information can be tested against the Answerer's other answers or by propositions accepted as factual evidence in order to find an inconsistency (Dunne et al., 2005; Walton, 2008).

This testing function of examination can often be quite aggressive in nature as indicated by the various Greek words used for it by Aristotle, including testing, refuting, attacking and destroying (Fink, 2012, 5). The use of this terminology suggests that examination tests what the Answerer says by using the strongest possible arguments to attack it, then gets arguments to attack the attacks, and then weighs on a balance which side has the stronger arguments. By this means the test can be passed or it can fail. The reliability of information acquired can be tested by (1) counter-arguments, (2) comparing to other commitments of the Answerer, or (3) comparing to known facts.

For studying the properties of examination dialogue, it is best to begin with the simplest model, where only yes-no questions are allowed, and then to expand to building more complex varieties where different kinds of questions are also allowed. So we could begin with Aristotelian dialectic, modeled by the formal dialectical system *ACADEMIC*₁, and add to the rules of this system to build a variety of different more complex models that could be used to model more complex types of instances of examination dialogue. There are two problems with this research program. One is that the following question needs to be answered: what is the difference between

persuasion dialogue and examination dialogue? The other is that that of drawing the distinction between examination arguments and dialectical arguments on Aristotle's view of these matters.

Hamblin (1971, 59) cited three passages in *On Sophistical Refutations* (169b 25, 171b 4, 172a 23). He concluded from examining these passages that Aristotle was not sure whether dialectical and examination arguments are the same or different. Aristotle contrasted examination arguments with contentious arguments, but there does not seem to be a clear distinction made between dialectical and examination arguments. Hamblin (1970) pointed to ambiguities suggesting that Aristotle may have sometimes held that the view that dialectical and examination arguments are in the same category. Hamblin (1970, 59) cited the passage in *Topics* 159a25 as evidence for the view examination arguments are species of dialectical arguments.

In the standard dialogue typology of Walton and Krabbe (1995), persuasion dialogue is a type of dialogue where one party uses the commitment of the other party to try to get the other party to come to accept the thesis of the first party. At the opening stage, what the Greeks called a *stasis*, representing the thesis to be proved by the proponent, is identified (Hohmann, 1989). The respondent can have one or the other of two roles, to be determined at the opening stage. He can try to prove the opposite proposition or he can play the role of skeptic, by casting enough doubt on the proponent's attempts to prove his thesis. The two parties each have an individual commitment store (Hamblin, 1970; 1971), a database containing all of the propositions accepted by either party at the opening stage, and updated as each party makes a next move (Prakken, 2011). They take turns making moves, and each move contains a move, such as the move of making an assertion or the move of putting forward an argument (Prakken, 2006).

The critical discussion type of dialogue (van Eemeren and Grootendorst, 2004) is taken to be a species of persuasion dialogue (Walton, 2013), but it is quite different from the kind of persuasion dialogue found in legal cross-examinations.

5. Cross-Examination in Law

Terence E. MacCarthy was the executive director of the Federal Defender Program in the US district court for the Northern District of Illinois for more than forty years. He polished his views about cross-examination in federal trials and by teaching groups of lawyers how to improve their cross-examination skills. According to MacCarthy (2007, 3) lawyers cross-examine so poorly because they do not understand the purpose of cross-examination, partly because leading lawyers and commentators have given incomplete or inaccurate answers to the question of what the goal of a cross-examination should be. Some say the goal is to extract admissions from a witness, to control a witness, or to discredit the witness by challenging his or her recollection. In MacCarthy's view, these goals apply to some part of most cross-examinations, but do not correctly specify the ultimate goal of every cross-examination. The goal of cross-examination is PERSUASION (he put this word in caps) which means to persuade the judge or jury, through the opening and examination stages to the closing argument, to accept the client's version of the facts (MacCarthy, 2007, 4). This account rests on the assumption that cross-examination is a special type of dialogue that needs to be seen as fitting into the larger persuasion type of dialogue in the trial format, so that the goal of the examination interval should be seen as that of supporting the ultimate goal of the trial as a procedure in which it is embedded.

MacCarthy observes that too often lawyers think that the goal of cross-examination should be to hurt the witness by making him look bad. However, what this does at best it is to neutralize the witness, whereas it may be possible to turn the witness into a positive factor in supporting the

examiner's case. In his view the goal of cross-examination should be to make the examiner look good by telling a story and using the story to persuade, even if the witness is not cooperating (MacCarthy, 2007, 4). This view of the goal of cross-examination can be compatible with the view the goal of examination generally, which is to use information extracted by questioning to support the ultimate goal of persuasion imposed by the burden of persuasion set at the opening stage of the trial. If the examination is embedded in a persuasion dialogue, and it is possible to extract information from a witness that can support the goal of the persuasion dialogue, then the extraction of that information in such a way as to help fulfill the Questioner's burden of persuasion can also be seen as expressing part of the goal of cross-examination. Moreover, if trapping the witness in an inconsistency casts doubt on whether the witness's story holds up, this finding is relevant to the trial as a whole, precisely because it carries evidential weight by shifting an evidential burden, and therefore contributes the overall persuasion goal of the trial.

MacCarthy's views are insightful and based on a wealth of practical experience. Although he is a valuable source on the nature of cross-examination as an argumentation skill lawyers need to learn, his remarks above about the structure of cross-examination need to be seen as representing the point of view of the lawyer exercising this task in a trial setting. But that is not the only viewpoint one can take on examining cross-examination.

In this paper we need to take a different point of view, one characteristic of argumentation theory, to represent the normative structure of the dialogue using an abstract model that represents the roles of all the participants as they interact in a formal dialogue structure. In this view cross-examination can be seen as a formal procedure that has a goal set at the opening stage and rules that are binding on the moves made by all the participants who take part in it, including the judge, the jury, the lawyer who conducts the examination, and the witness being examined. Viewed from this abstract point of view of a normative model, the goal of an examination dialogue is to extract information from the witness being examined, information that, once brought out during the procedure, will provide evidence that is relevant to fulfilling the ultimate goal of the trial. The problem posed is that the propositions testified to by the witness are contestable. Witnesses are frequently known to lie, to make mistakes, to perceive things inaccurately, to forget what they saw, or even to present information held to be factual that is based on false memory. Cross-examination is the tool that can solve these problems.

A most valuable insight provided by MacCarthy's description of cross-examination is that its goal always needs to be seen as subservient to the ultimate goal of the trial as a legal procedure in the common law. There is always an ultimate issue to be resolved. For example in a criminal case, the ultimate issue is whether the defendant committed the crime or not. The prosecuting side has the burden of persuasion, whereas the defending side only has to show that the prosecution's side has not met its burden of persuasion, which is to show to the standard of beyond reasonable doubt that the defendant committed the crime. In order to understand cross-examination as an orderly procedure that has goals and permissible moves binding on both parties (the examiner and the witness) in order for the exchange to be successful in its intended legal purpose, its rules have to fit into the structure of the trial as a whole. From this viewpoint, the goal of the cross-examination dialogue should be to extract information that can be useful to the audience (the judge and/or the jury) to help them acquire evidence needed to fulfill the goal of the trial. If the circumstantial evidence is insufficient, the outcome of the trial may have to be decided on the evidential basis of the witness testimony.

6. The Speed Example

The following example of impeachment in cross-examination by use of prior inconsistent statements is a shortened version of the fuller version of the examination dialogue presented in (Mauet, 2005, 251-52):

- Q: Mr. Hoffman, can you say today that the Chevy was going 30 miles per hour?
 A: That's right.
 Q: You're sure about that speed?
 A: Yes.
 Q: Mr. Hoffman, was that Chevy actually going more than 50 miles per hour?
 A: No, I'd say more like 30.
 Q: Let's turn back to December 1, 2005. You testified that day at what's called a deposition, right?
 A: Yes.
 Q: The court reporter swore you in to tell the truth?
 A: Yes.
 Q: You signed the signature page saying that the deposition transcript was accurate, right?
 A: Yes.
 Q: Now look at page 42, line 15. I'm going to read from that page. "Question: did you see the Chevy before the crash? Your answer: yes I did. Question: how fast was the Chevy going when it crashed into the other car? Your answer: at least 50 miles per hour." Did I read those questions and your answers right, word for word?
 A: Yes.

I will call this example of cross-examination the speed example. The speed example can be configured in the formal dialogue format of ACADEMIC₁ as shown in table 4, using the conventions shown in the key list below.

Test30: You testified that the Chevy was going 30mph.

Test~50: You testified that the Chevy was not going 50mph.

TestDep: You testified in a deposition.

Swore: You swore to tell the truth.

Sign: You signed the form saying the deposition was accurate.

See: You testified that you saw the Chevy before the crash.

Test50: You testified in the deposition that the Chevy was going 50 miles per hour.

R	Questioner (Q)	Answerer (A)
1	<i>30/~30</i>	Concession <i>30</i>
2	Question <i>50</i>	Concession <i>~50</i>
3	Question <i>Test</i>	Concession <i>Test</i>
4	Question <i>Swore</i>	Concession <i>Swore</i>
5	Question <i>Sign</i>	Concession <i>Sign</i>
6	Question <i>See</i>	Concession <i>See</i>
7	Question <i>Test50</i>	Concession <i>Test50</i>
5	Argument <i>Swore, Sign, See, Test50/50</i>	Concession <i>50</i>
8	Inconsistency (<i>50,~50</i>)	A loses

Table 4: Dialogue for the Speed Example

The argumentation strategy of the cross-examiner in the speed example is represented in the conflict diagram in figure 3. On the right, Hoffman's testimony in the prior deposition where he stated that the Chevy was actually going more than 50 miles an hour is shown. This testimony is prefaced by the three previous questions that, once given affirmative answers by Hoffman, nail down his statement that the Chevy was going 50 miles an hour or more. All four of Hoffman's answers, shown as four arguments from commitment a3-a6, nail down his commitment to his testimony that the Chevy was going 50 miles an hour or more.

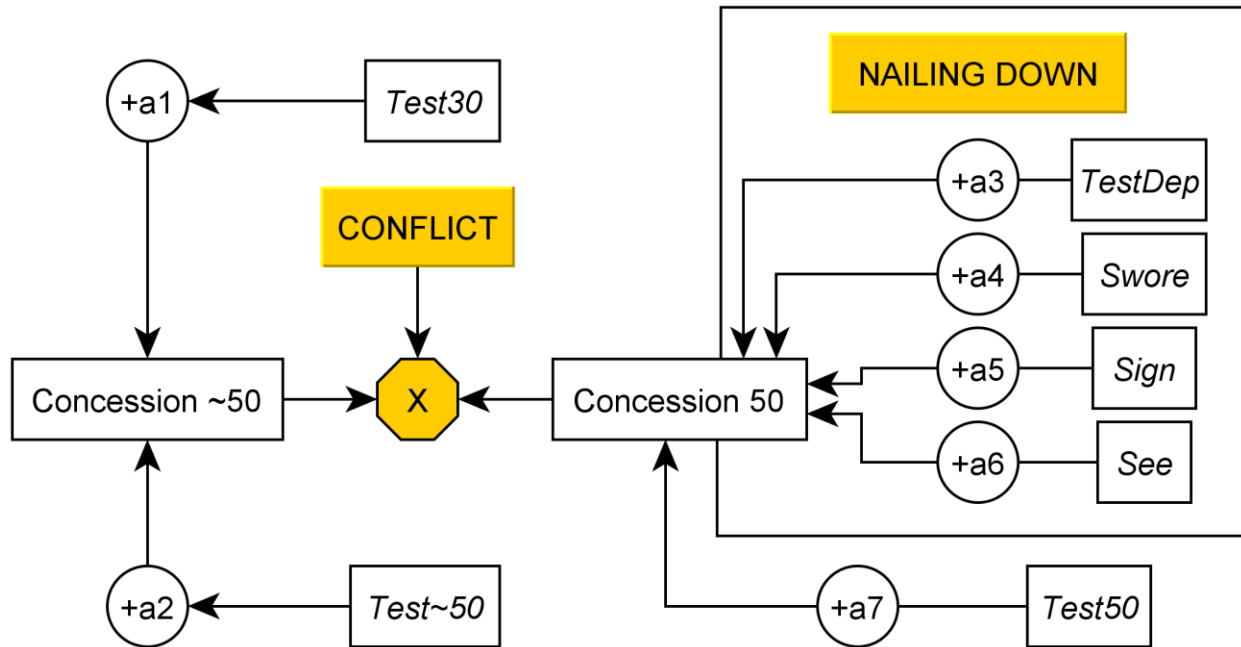


Figure 3: Conflict Diagram of the Speed Example

Hence in the conflict diagram, arguments a3 to a5 provide evidence showing that Hoffman conceded that he has gone on record and is committed to the statement that the Chevy was going more than 50 miles an hour. A part of the dialogue sequence can often be identified as a *nailing down of a commitment*, a sequence of moves just before the commitment is extracted from the respondent that is designed to leave him no wiggle room to escape the concession. This part of the argumentation sequence is shown in the large rectangle at the right side of figure 3. Nailing down of a commitment can be precisely defined as a six-step procedure and modeled using an algorithm, as shown in section 9.

At the left side of figure 3, there is an argument with two premises showing that in the trial Hoffman testified that the Chevy was only going 30 miles an hour, and that therefore this testimony implies that the Chevy was not going 50 miles an hour. The conclusion is then drawn that Hoffman is conceding in his testimony in the trial that the Chevy was not going 50 miles an hour or greater. Hence the conflict between the testimony on the left side of figure 3 and testimony on the right side is clearly shown by the conflict symbol represented by the octagonal node containing the X.

7. The Elbow Example

The second example is also a shortened version of a real cross-examination dialogue in a trial presented by Mauet (2005, 447). I will call it the elbow example. A special feature of this example is that it represents a conflict between the opposed testimony of a pair of expert witnesses, a widely significant kind of cross-examination based on a conflict between two expert witnesses where the testimony of one is inconsistent with the testimony of the other. Expert witness testimony is extremely common in law (Myers, 1965), and cross-examination of expert witness testimony is an important type of examination dialogue in law (Levy, 2011, 313-368).

Q: Doctor, your view is that if the patient does the prescribed physical therapy, every patient should return to a full range of motion in the elbow joint?

A: Yes, that's what the therapy is intended to accomplish.

Q: And your view is that if the patient does that therapy, he should always be able to have a full range of motion?

A: Yes.

Q: Doctor, you're familiar with Goldstein's medical treatise called *Orthopedics and Trauma*?

A: Yes.

Q: In fact, that treatise is recognized as a reliable authority in the field of orthopedics, right?

A: I think that's probably true.

Q: In fact, you have a copy of the treatise in your office library, don't you?

A: Yes.

Q: Doctor, I'm going to read from page 734 of Goldstein's treatise: "When elbow dislocations cause enough damage to soft tissues in the joint, therapy alone may not result in the return of full range of motion. Medical studies have shown that 10% to 20% of such patients experience an incomplete recovery." Doctor, did I read that right?

A: Yes.

Here is the key list for the elbow example, where GT refers to Goldstein's treatise.

Every: Every patient who does therapy should return to a full range of motion.

AsaysEvery: A says that every patient who does therapy should return to a full range of motion.

Aex: A is a reliable authority.

Always: If the patient does the therapy, he should always have a full range of motion.

GTex: GT is a reliable authority [an expert source in orthopedics].

Fam: A is familiar with GT.

Copy: A has a copy in his office library.

MayNot: With enough damage, therapy may not result in full range of motion.

GTsaysMayNot: It says in GT (quoted) that with enough damage, therapy may not result in full range of motion.

Med: Medical studies have shown 10-20% of patients have incomplete recovery.

The formal dialogue structure of this cross-examination in ACADEMIC1 is shown in table 5.

R	Questioner (Q)	Answerer (A)
1	Question <i>Every</i> /~ <i>Every</i>	Concession <i>Every</i>

2	Question <i>Always</i>	Concession <i>Always</i>
3	Question <i>GTex</i>	Concession <i>GTex</i>
4	Question <i>Fam</i>	Concession <i>Fam</i>
5	Question <i>Copy</i>	Concession <i>Copy</i>
6	Question <i>GTsaysMayNot</i>	Concession <i>GTsaysMayNot</i>
7	Question <i>Med</i>	Concession <i>Med</i>
8	Argument <i>If (GTex and GTsaysMayNot) then MayNot</i>	Concession <i>MayNot</i>
9	Argument <i>If MayNot then ~Always</i>	Concession <i>~Always</i>
10	Inconsistency (<i>Always, ~Always</i>)	A loses

Table 5: Dialogue for the Elbow Example

In the speed example the conflict of commitments of the respondent shown in the cross-examination was clear and straightforward. First Mr. Hoffman replied that the Chevy was only going 30 miles an hour, but then the cross-examiner showed that in previous testimony during a deposition, he had stated that the Chevy was going at least 50 miles an hour. It is logically impossible for a Chevy to go 30 miles an hour, and at the same time go at a speed of at least 50 miles an hour. Here we have a clear case of a conflict between two commitments of the respondent. That there is such a conflict in the elbow case is less evident.

8. Conflicting Expert Opinions

To understand the nature of this kind of expert witness conflict, we have to look more carefully at the argumentation in the elbow example. First the Answerer commits to a particular proposition, but then next in the sequence of cross-examination the Questioner makes sure through the nailing down procedure that the Answerer commits to a sequence of preliminary propositions before leading up to revealing the conflict. The Answerer agrees that he is familiar with GT. Then he concedes that the treatise is recognized as a reliable authority in the field of orthopedics. Next he admits that he has a copy of this treatise in his office library. These three moves in the dialogue constitute the nailing down procedure in the elbow case. Once these propositions are nailed down as commitments, we have the following form of conflict: the Answerer commits to a proposition P_0 , but also commits to another expert source that clearly states $\sim P_0$. This form of conflict is one that is central to many cases of cross-examination of experts in trials. It is not a direct logical contradiction, but kind of indirect contradiction mediated through commitment to the stated opinion of an expert source.

The logical structure of this kind of conflict can be more fully revealed by considering the scheme for argument from expert opinion as given in (Walton, Reed and Macagno, 2008, 310) as follows. There are two instances of this argumentation scheme in figure 4.

Major Premise: Source E is an expert in subject domain S containing proposition A .

Minor Premise: E asserts that proposition A is true (false).

Conclusion: A is true (false).

This type of argument is defeasible. It holds only as a tentative inference that can be defeated by a counter-argument. Critical questions can shift the burden of proof to the proponent of the argument. The conflict in the elbow example is mediated through this scheme as follows.

First Commitment: Expert 1 commits to P_0 .

Second Commitment: Expert 1 commits to the expertise of Expert 2.

Third Commitment: Expert 2 commits to $\sim P_0$.

This kind of conflict can be called an *indirect conflict of commitments* of the following type: a conflict of commitments mediated through a pair of arguments from expert opinion which lead to opposite conclusions. Since the doctor in the elbow example is an expert, his testimony leads by argument from expert opinion to P_0 , whereas GT is an expert source quoted that declares $\sim P_0$.

To see this, we have to look back at the cross-examination in the elbow example. First, the Answerer states that the patient should always be able to have a full range of motion, but then later by the nailing down procedure of the cross-examiner he admits that GT is recognized as a reliable authority. Moreover he even admits that he has a copy of GT in his office library, suggesting that he considers it a reliable expert source of trustworthy medical information. Then he has to admit that the statements quoted from GT directly contradict this earlier concession. So the conflict is one between his (expert) pronouncement and that of another expert medical source that he is committed to taking as a reliable authority.

The conflict diagram in figure 4 displays the structure of the argumentation strategy used by the cross-examiner to show the conflict of expert opinions.

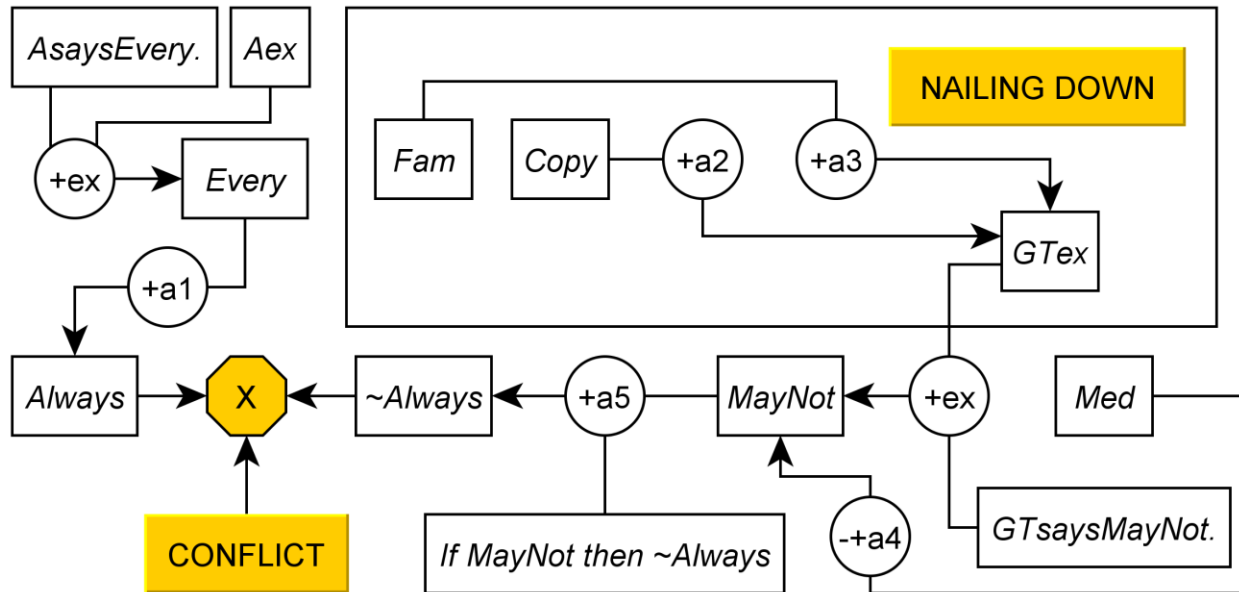


Figure 4: Conflict Diagram of the Elbow Example

In figure 4 the expression +ex in an argument node indicates an instance of the scheme for argument from expert opinion supporting (pro) a conclusion. The procedure is shown by the examiner's questions nailing down the Answerer's commitment to the statements that GT is recognized as a reliable authority, that the Answerer is familiar with GT and that the Answerer even has a copy in his office library. The Questioner clinches the cross-examination by quoting GT saying that with enough damage therapy may not result in full range of motion. At the bottom right in figure 4, the conflict is generated by this concession and by its support from another statement quoted in the book giving the factual information that medical studies have

shown that 10 to 20% of patients have incomplete recovery (*Med*). This statement (every) is shown as supporting the statement ‘always’. By this means the conflict is shown at the left side of the conflict diagram where the argument +a1 supports the conclusion ‘always.’

First the doctor stated that every patient treated by this physical therapy should always be able to have a full range of motion. Later, he did not commit to the opposite of the proposition, but he did indirectly commit to the proposition that it says in GT that therapy alone does not result in the return of full range of motion. Here we have a phenomenon that is commonplace in trials, a conflict between expert testimonies, sometimes called the battle of the experts (Myers, 1965). In this case then, as shown by the conflict diagram in figure 4, there is an indirect conflict of commitments created by a conflict of expert opinions.

Even though the contradiction is now expressed as indirect one might still be inclined to object that possession of a particular book in one’s personal library indicates no support for the propositional content of that book, and that agreeing that something is recognized as a reliable authority in the field does not bind one to personally agree with every statement of that authority. One can agree that possession of a book in one’s library does not support propositional content in the book by deductive reasoning, and also that it does not bind one to personally agree with every statement in the book. However, in the elbow example, once the witness admits that this particular book is in his personal library, there is a presumptive inference, a kind of Gricean implicature (Macagno and Walton, 2013), suggesting that the witness attaches some significance to this book as a source of medical information. This is not a deductive inference, however. It is a presumptive inference of a kind that juries often take fairly seriously in evaluating witness testimony, and judges and lawyers are often very careful to deal with because they know that such suggestions will have evidential impact in directing a jury to one side or the other on a disputed issue.

9. The BER Algorithm for Blocking Easy Retraction in Cross-examination

The procedure of nailing down a commitment can be defined more precisely as a specific procedure by modeling it as an algorithm. The immediate goal of carrying out the procedure is to provide a cumulative buildup of evidence showing that the answerer *A* in an examination dialogue is committed to a proposition P_n (the proposition at issue) even before the questioner *Q* puts the direct question to *A* whether he is committed to P_n . The long term goal is for *Q* to have a tool to use to forestall any attempt made by *A* to retract commitment to P_n if *A* is asked directly whether he is committed to P_n . This goal can be achieved by *Q* by carrying out the following sequence of steps in a procedure which I will call the BER, the algorithm for blocking easy retraction of a commitment in cross-examination dialogue.

- Prior to questioning *A*, *Q* collects a set of evidential propositions $E = \{P_1, P_2, \dots, P_i\}$ supporting the claim that *A* is committed to proposition P_n .
- *Q* puts the series of questions $P_1?$, $P_2?$, $P_i?$ to *A*.
- *Q* formulates the questions so that that when answered affirmatively, each succeeding question has P_1, P_2, \dots, P_i is a direct answer.

- Once A asserts a proposition P_i as a direct answer to each question, A becomes committed to P_i and P_i is inserted into his commitment store.
- Q now has a cumulative sequence of arguments a_1, a_2, \dots, a_i based on A 's commitments P_1, P_2, \dots, P_i that support the claim that A is committed to proposition P_n .
- Q can repeat the arguments a_1, a_2, \dots, a_i if A tries to retract his commitment to P_n at this point in the dialogue.

Applying the BER algorithm to nail down a commitment in a cross-examination can be displayed in a given example as taking the form of a subgraph of an argument graph. An example is shown in the large rectangle on the right of 3, and another example is given in the large rectangle at the top right of figure 4.

10. Conclusions

For reasons of length, this paper has been confined to two relatively short and simple illustrative examples of cross-examination dialogue. The first one falls into the category of prior inconsistent statements, where a statement attested to by the witness is shown to be inconsistent with prior statement he committed himself to. The second one falls into the category of cross-examination of an expert witness by showing a conflict with testimony of another expert witness. The first example, it is argued, fits the formal system. The second one does not, but it is shown how it can be managed by the system using argumentation schemes.

These two examples were picked because each of them represents a very common type of argumentation strategy widely used in cross-examination in trials (Levy, 2011). In the speed example, the examination dialogue fits the Aristotelian structure straightforwardly because something said by the witness in one place directly contradicts something he said in another place in the sequence of dialogue. In the elbow example there is only an indirect conflict of commitments. The first expert testifies to one factual proposition, going on record as claiming that this proposition is true. But on the other hand this expert is also committed to the trustworthiness of a book written by another expert, because he has answered a question by agreeing that his treatise is recognized as a reliable authority in the field of orthopedics, and that in the book there is a statement by the author that directly conflicts with this proposition.

When compared, the analyses of the two examples shows that there is an inherent difference in the logical structures of the argumentation in them displayed in the two argument diagrams. If an arguer's set of commitments contains a logical inconsistency of the kind shown in the speed example, it shows that this set of propositions cannot all be true. This casts doubt on the acceptability of the testimony as a whole. In contrast, there is no logical contradiction in the testimony put forward in the elbow example. There is a kind of conflict, however, that has been revealed because it cannot be the case that both experts are right on what they claim. If what the one expert said is true with the other expert said must be false, so we are forced to choose between the two experts' testimonies. This kind of conflict, although it is not a logical inconsistency of the kind required by Aristotelian dialectic and its formal model $ACADEMIC_1$, does cast doubt on the testimony of the expert physician being examined.

Hence there is an inherent difference in how the technique of the cross-examiner works in the two examples. The speed example can be straightforwardly analyzed using the formal structure

of ACADEMIC₁. But to analyze the structure of the argumentation to reveal the conflict in the elbow example it was necessary to use additional tools. Dealing with this example involves argumentation schemes, and most prominently the scheme for argument from expert opinion.

It has been shown by studying these two examples of cross-examination that the argumentation structures in cross-examinations can be analyzed using the formal dialogue model ACADEMIC₁ along with additional argumentation tools. But even more importantly for practical purposes, it has also been shown using these two examples how conflict diagrams can be drawn that offer a useful way of elucidating a cross-examiner's strategy. Once the central core of the examination dialogue is represented in a dialogue table, the argumentation structure of the examination dialogue can be revealed by mapping the table onto a conflict diagram. These findings offer a practical method for analyzing and evaluating the argumentation that takes place in some common kinds of examination dialogue. Further research can test how well the method works when it is applied to more complex examples.

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